

What is claimed is:

1. Apparatus for directing electromagnetic energy onto a target in a small area of illumination, said apparatus comprising, in combination,

a source of electromagnetic radiation,

a substantially planar light barrier interposed between said source and said target, said light barrier defining a first electrically conductive surface on the side of said barrier exposed to incident light from said source and further defining a second surface on the opposite side of said barrier, said second surface being positioned adjacent to said target,

one or more apertures through said light barrier, each of said apertures passing from said first surface to said second surface and having a width in at least one dimension that is smaller than one wavelength of said electromagnetic radiation, and

means for limiting the extent of the electronic excitation induced in said second surface in the vicinity of each of said apertures.

2. Apparatus as set forth in claim 1 wherein said means for limiting the extent of the electronic excitation induced in said second surface in the vicinity of each of said apertures comprises a barrier material that is opaque to the transmission of said electromagnetic radiation formed in said light barrier and positioned between said first electrically conductive surface and said second surface.

3. Apparatus as set forth in claim 2 wherein said first electrically conductive surface is formed by a layer of conductive metal having a thickness greater than the skin depth of said metal at the frequency of said electromagnetic radiation.

4. Apparatus as set forth in claim 3 wherein said layer of conductive metal extends into the interior side walls of each of said apertures terminating at said second surface in a limited area in the vicinity of each of said apertures.

5. Apparatus as set forth in claim 3 further including a confined conductive area at said second surface in the vicinity of each of said apertures whereby surface

excitations at said second surface are confined to the vicinity of each of said apertures.

6. Apparatus as set forth in claim 5 wherein a layer of conductive metal is positioned at said second surface and a groove is formed in said layer of conductive metal surrounding each of said apertures to define said confined conductive area.

7. Apparatus as set forth in claim 2 wherein said barrier material is a dielectric that exhibits a bandgap that is larger than the frequency of said electromagnetic radiation.

8. Apparatus as set forth in claim 2 wherein said electrically conductive surface is constructed of a layer of a first metal and wherein said barrier material is a different metal characterized in that said conductive surface and said barrier material have substantially different resonances.

9. Apparatus as set forth in claim 7 wherein said first electrically conductive surface is formed by a layer of conductive metal having a thickness greater than the skin depth of said metal at the frequency of said electromagnetic radiation.

10. Apparatus as set forth in claim 9 wherein said layer of conductive metal extends into the interior side walls of each of said apertures terminating at said second surface in a limited area in the vicinity of each of said apertures.

11. Apparatus as set forth in claim 9 further including a confined conductive area at said second surface in the vicinity of each of said apertures whereby surface excitations at said second surface are confined to the vicinity of each of said apertures.

12. Apparatus as set forth in claim 11 wherein a layer of conductive metal is positioned at said second surface and a groove is formed in said layer of conductive metal surrounding each of said apertures to define said confined conductive area.

13. Apparatus as set forth in claim 7 wherein said electrically conductive surface is constructed of a layer of a first metal and wherein said barrier material is composed of a dielectric and a different metal characterized in that said conductive surface and said barrier material have substantially different resonances.

14. A device for directing small areas of illumination onto a target comprising, in combination,

a source of electromagnetic radiation,

a substantially planar light barrier positioned between said source and said target, said light barrier being opaque to said electromagnetic radiation and defining a first surface facing said source and a second surface facing said target, and further comprised of a layer of metal affixed to said first surface,

an array of one or more apertures through said light barrier, each of said apertures having a width in at least one direction which is shorter than the wavelength of said electromagnetic radiation, and

a confined area in the vicinity of each of said apertures at said second surface, said confined conductive area being electromagnetically coupled to said layer of metal at said first surface such that surface excitations are induced in said confined conductive area to produce said small areas of illumination.

15. The device set forth in claim 14 wherein light barrier has a thickness on the order of 200 nm.

16. The device set forth in claim 14 wherein said light barrier is selected from a group of dielectric materials including germanium, silicon dioxide, silicon nitride, alumina, and chromia.

17. The device set forth in claim 14 wherein each of said one or more apertures has a width in at least one direction that is between 10 nm and the dimension defined by the Rayleigh criterion for said frequency of electromagnetic radiation.

18. The device set forth in claim 14 wherein said layer of metal has a thickness at least as large as the skin depth of said metal at the frequency of said electromagnetic radiation.

19. The device set forth in claim 14 wherein said metal is selected from a group consisting of gold, silver, aluminum, beryllium, rhenium, osmium, potassium, rubidium, cesium, rhenium oxide, tungsten oxide, and copper.

20. The device set forth in claim 14 wherein each of said apertures in said array is a slit having a long dimension and a shorter width dimension, said shorter width dimension being smaller than the wavelength of said radiation

21. The method of directing electromagnetic radiation from a source to a confined area on a target, which comprises, in combination, the steps of:

interposing a radiation barrier between said source and said target, said radiation barrier comprising a substantially planar material that is opaque to said electromagnetic radiation defining a first surface closest to said source and an opposing surface closest to said target, said radiation barrier having an aperture therethrough having a width in at least one dimension which is smaller than one wavelength of said electromagnetic radiation, said barrier further comprising a layer of electrically conductive metal covering said first surface, and

activating said source to direct said radiation from said source onto said layer of electrically conductive metal to induce surface excitations in said layer of metal, and

positioning said aperture adjacent to said target such that electromagnetic energy passing through said aperture induces surface excitations in said confined conductive area to illuminate said target with said small area of illumination.

22. The method of claim 21 wherein said material that is opaque to said electromagnetic radiation is a dielectric having a bandgap that is larger than the frequency of said electromagnetic radiation.

23. The method of claim 21 wherein said material that is opaque to said electromagnetic radiation is metallic material different from said electrically conductive metal and having a substantially different resonance.

24. Apparatus as set forth in claim 1 wherein said target is an optical data storage medium.

25. Apparatus as set forth in claim 1 wherein said target is a sample placed between the objective lens of a microscope and said second surface.

26. Apparatus as set forth in claim 1 wherein said target is a photoresist, which is exposed by said electromagnetic radiation in a lithographic process.